JOURNAL OF BALTIC SCIENCE EDUCATION

ISSN 1648-3898 /Print/
ISSN 2538-7138 /Online/

RISK PERCEPTION AND RESPONSE TO NATURAL HAZARDS WITHIN SCIENCE CURRICULUM

Ni Wayan Rai Utari Dewi,
Wonbin Jang,
Minchul Kim

Abstract. *Natural hazards pose global risks making it essential to incorporate risk perception and response strategies into science curricula. This study analyzed the distribution of risk perception and response indicators for natural hazards—including earthquakes, tsunamis, typhoons, landslides, floods, droughts, volcanoes, wildfires, storms, and extreme temperatures (heat waves, cold waves)—in lower secondary science curricula: the Cambridge Lower Secondary Curriculum 2020 (UK), Indonesia Merdeka Curriculum 2022, South Korea Curriculum 2022, and Singapore Lower Secondary Express and Normal (Academic) Curriculum 2021. A descriptive qualitative content analysis was conducted by analyzing curriculum documents to evaluate risk perception and response indicators distribution. The findings show that the distribution of risk perception and response to natural hazards in specific science curricula does not align with the geographic characteristics of the respective regions. Furthermore, risk perception is given greater emphasis than response strategies, creating an imbalance in the lower secondary science curriculum. This study suggests the need to modify the explanation of risk perception and response to natural hazards in the science curriculum, which emphasizes a global approach that broadens understanding beyond local hazards to prepare individuals for risks they may encounter while moving, traveling, or living in other countries.*

Keywords: *natural hazards, risk perception, risk response, science curriculum, secondary school*

Ni Wayan Rai Utari Dewi, Wonbin Jang, Minchul Kim
Kongju National University, Republic of Korea

Introduction

Natural hazards affected people including children, infrastructure, and economic losses. Natural hazards cause significant risks to human life, both presently and in the foreseeable future. According to Bertoli et al. (2023), approximately 175 million children are impacted by natural hazards each year. International Federation of Red Cross and Red Crescent Societies (2022) also explained that an average of 44 countries per year, in the last 30 years, have been impacted by simultaneous disasters. Between 1994 and 2013, the Emergency Event Database (EM-DAT) recorded there were 6,973 natural disasters worldwide, and people who were affected reached 218 million annually over 20 years (Centre for Research on the Epidemiology of Disasters (CRED), 2015). In 2020, a total of 388 disasters occurred globally (Asian Disaster Reduction Center, 2023). Moreover, an earthquake occurred in the Sichuan Province with a magnitude of 8 SR, killing approximately 70,000 people, and the Kobe earthquake, in 2005, killed over 6,000 people (Asian Development Bank, 2013). Likewise, about 80% of tsunamis occur in the Pacific Ocean (Pan American Health Organization, 1994). Additionally, demographic growth, globalization, prevalent poverty, especially in hazardous areas, and dynamic climate will be causing the risk along with greater natural hazards in the future, which is associated with more population at risk (International Strategy for Disaster Reduction, 2009). For children and young people, natural hazards raise threats to their protection, physical health, and overall development (UNICEF, 2020).

In this world, various types of natural hazards have occurred and may happen in the future due to the risks that emerge from the natural disaster phenomenon. Depending on the geographic area, natural hazards occur differently. A natural hazard is defined as a natural process and event that poses a potential threat to the life of humans and property, while a disaster is described as a hazardous event that occurs within a certain zone in a limited period (Keller & Devecchio, 2015). For instance, the geographic features of the United Kingdom include hills, low mountains, rivers, and beaches (Koterba, 2019). Hills, rivers, beaches, low mountains, and plentiful rainfall all year round trigger the frequent occurrence of natural hazards such as floods (coastal flooding and river flooding), landslides, and relatively small volcanic

https://doi.org/10.33225/jbse/25.24.239

ISSN 1648–3898 /Print/
ISSN 2538–7138 /Online/

eruptions (Giles, 2020; Koterba, 2019; Stock & Wentworth, 2019). The sediment along Scotland's north-eastern coasts and at locations in northeast England has been characterized as tsunami deposits and ascribed to a major submarine landslide (Giles, 2020). The most tectonically and seismically active area is at the northwest corner of Wales. However, the earthquake's seismic risk is classified as low to moderate (Giles, 2020). Summers are the warmest, reaching temperatures that can rise above 35°C in the southeast of England, which is closest to the European mainland, leading to natural hazards including droughts and heat waves (Koterba, 2019; Stock & Wentworth, 2019). Moreover, Indonesia is located near the Ring of Fire (tectonic belt, volcanic mountain) and sea (Pambudi, 2018). Since Indonesia is in the Ring of Fire, the types of natural hazards that frequently occur are earthquakes, volcanic eruptions, and tsunamis (Protschky, 2022). The geography of South Korea is along the coastlines of the south, east, and west seas, consisting of mountains, rivers, plains, and the proximity of tectonic plate boundaries along the Pacific Rim (Kwon et al., 2016; National Geographic Information Institute, 2017), which contributes to the types of natural hazards prevalent in the region including river flooding, the potential of earthquake and volcanoes (Kang & Skidmore, 2018; Kim & Yoon, 2020; National Geographic Information Institute, 2017). In addition, South Korea's geographic position also places it within the path of many typhoons that originate in the western part of the North Pacific Ocean, which bring destructive wind, waves, storm surges, heavy rain, and landslides (National Geographic Information Institute, 2017). The coldness that originated from China gathered moisture from the warmer Yellow Sea, resulting in a thick snowfall across Korea, which triggered a cold wave (National Geographic Information Institute, 2017). Additionally, in Singapore, which is mostly low-lying and flat terrain (Bai et al., 2023), the types of natural hazards that are caused by the surrounding countries are earthquakes and tsunamis in a low seismic hazard area (Lai & Tan, 2013).

Since every country has its natural hazards, reduction of the risk impact of natural hazards can be implemented through a science curriculum, particularly about the explanation of risk perception and response to natural hazards. Bertoli et al. (2023) have argued that children must cultivate awareness of natural risks to mitigate or diminish the adverse effects of these events. Moreover, according to Cerulli et al. (2020), education contributes to the reduction and alleviation of losses inflicted by disasters. Preparedness strongly depends on school education, especially science learning. According to the International Strategy for Disaster Reduction (2009), science has contributed and is recognized as an important key in the successful strategy of risk reduction. One of the subjects that has the potential to be integrated with disaster risk reduction efforts is natural science (Tyas, 2020). Risk perception is vital for adequate preparedness (Mărgărint et al., 2023). Risk perception is explained as beliefs regarding harmful potential or loss possibility (Darker, 2013). Risk perception is outlined as the competence to identify and evaluate the risk related to hazardous events (King & Blickensderfer, 2023). Studies on risk perception examined the assessments individuals make when classifying and evaluating hazardous activities (Slovic, 1987). Risk perception denotes the subjective evaluation of the likelihood of a specific accident occurring and the level of apprehension regarding its consequences (Sjöberg et al., 2004).

Further, risk responses to risk are generally placed into one of four categories, such as reduce risk, remove risk, transfer risk, or accept risk (Sweeting, 2017). Risk response planning involves formulating alternatives and identifying risk responses that reduce dangers (Javid et al., 2020). In individual and social-cultural factors, prior personal experience with natural hazards has altered how people perceive and react to danger (Luis-Angel et al., 2022). Analyzing the explanation of risk perception and response to natural hazards in the science curriculum leads to the objective of this study, to what extent students are informed about these types of natural hazards. The comprehension of perceiving the risk perception and response allows students to reduce the risk of these hazards and respond effectively to the impact. Although previous studies have explored risk perception and response strategies to natural hazards, limited research has examined how these concepts are integrated into science curricula. Most existing studies focus on general disaster education, emergency preparedness, or community resilience, but there is a lack of research analyzing whether science curricula adequately prepare students for natural hazard risks. Hence, this study analyzed the distribution of risk perception and response to natural hazards through the science curriculum. By analyzing how risk perception and response are incorporated into the science curriculum, this study intends to bridge the gap between theoretical knowledge and practical preparedness, ensuring that students can effectively perceive risks and respond appropriately to natural hazards.

Research Problem

This research problem addresses the gap by critically analyzing how risk perception and response to natural hazards are presented in science curricula. The complexities of natural hazards are not adequately explained in

https://doi.org/10.33225/jbse/25.24.239

ISSN 1648–3898 /Print/
ISSN 2538–7138 /Online/

the current science curricula, which impacts the sufficient preparation of students to understand risks and the lack of decision judgment during such events. For students to effectively respond to natural hazards, it is necessary to evaluate whether the current science curriculum discussing content on natural hazards and related risk responses aligns with their practical skills and knowledge. Furthermore, analyze whether this presentation of risk perception and risk response within the science curriculum is effective in developing students' understanding and preparedness. Despite the rising frequency of natural hazards and their impact, there is limited knowledge of how effective risk perception and appropriate response strategies are taught in the science curriculum.

Research Aim and Research Questions

The purpose of this study was to analyze how risk perception and responses to natural hazards are integrated and distributed within the lower secondary science curricula. This research analyzed the risk perception and response indicators to natural hazards, including earthquakes, tsunamis, typhoons, landslides, floods, droughts, volcanoes, wildfires, storms, heat waves, and cold waves within lower secondary science curricula including four countries such as Indonesia, South Korea, the United Kingdom, and Singapore. The distribution of risk perception and risk response in the science curriculum of each country is examined.

The research questions in this study were as follows:

1. Does the lower secondary science curriculum in Indonesia, South Korea, the United Kingdom, and Singapore address risk perception and response to natural hazards in alignment with their geographic characteristics?
2. How are risk perception and response to natural hazards explained in the lower secondary science curriculum of Indonesia, South Korea, the United Kingdom, and Singapore?

Research Methodology

General Background

This research applied a descriptive qualitative research design. In a descriptive analysis, the data was labeled for summary in terms of a text, word, or short phrase (Miles et al., 2014). Content analysis was the chosen method to analyze the explanation of risk perception and response indicator to natural hazards, including earthquakes, tsunamis, typhoons, landslides, floods, droughts, volcanoes, wildfires, storms, heat waves, and cold waves, in the science curricula of Indonesia, South Korea, the United Kingdom (Cambridge Curriculum), and Singapore. Content analysis was chosen in this study because the subject of analysis consisted of curriculum documents in the form of text. Content analysis was outlined as a methodical, repeatable process for reducing a lot of text into a smaller number of content categories based on certain coding rules (Berelson, 1952). Systematically transforming many words into a concise summary of key findings was the objective of qualitative content analysis (Erlingsson & Brysiewicz, 2017). The researchers categorized and set the indicators of risk perception and response to natural hazards as shown in Table 5. This categorization and indicators were used to analyze the science curriculum document of each country. Descriptive analysis was used to report the results after the content analysis. The research was conducted from November 2023 to February 2025. This time frame allowed for the collection, analysis, and interpretation of curriculum documents from the selected countries. The scope of this study was focused on analyzing the distribution of risk perception and response indicators for natural hazards in the lower secondary science curricula of four specific countries: the Cambridge Lower Secondary Curriculum 2020 (UK), Indonesia Merdeka Curriculum 2022, South Korea Curriculum 2022, and Singapore Lower Secondary Express and Normal (Academic) Curriculum 2021. The natural hazards examined in this research included earthquakes, tsunamis, typhoons, landslides, floods, droughts, volcanoes, wildfires, storms, and extreme temperatures (heat waves and cold waves). The methodological steps in this research are shown below.

Approach

This research analyzed the risk perception and responses to natural hazards within science curriculum documents from South Korea, Indonesia, the United Kingdom, and Singapore. This study utilized an inductive content analysis method to organize and categorize the content for descriptive purposes systematically. A systematic strategy for assessing qualitative data, guided by specific objectives, was called an inductive approach (Thomas, 2006).

https://doi.org/10.33225/jbse/25.24.239

ISSN 1648–3898 /Print/
ISSN 2538–7138 /Online/

Analysis Procedure

Figure 1 describes the steps of the data collection procedure in this study. The data collection procedure began with a preparation document and review of the science curriculum for Indonesia, South Korea, and Cambridge as representatives of the United Kingdom, and Singapore. These countries were chosen according to the risk impact classification shown in Table 1. Afterward, researchers identified the risk perception and risk response elements within the science curriculum of each country and categorized them into coding schemes as depicted in Table 5.

Figure 1
Data Collection Procedure

Step 1	Preparation	Sample preparation of science curriculum documents for South Korea, Indonesia, the United Kingdom, and Singapore was conducted by reviewing the Ministry of Education resources from each country, relevant textbooks, and websites related to their curricula.
	⇩	
Step 2	Review of science curriculum documents	Once the science curriculum documents were prepared, the researchers reviewed them to identify the types of natural events examined in this study, such as earthquakes, tsunamis, typhoons, landslides, floods, droughts, volcanic eruptions, wildfires, storms, heat waves, and cold waves.
	⇩	
Step 3	Creation of a framework for risk perception and response	After reviewing the curriculum, which mentioned several natural hazards (including earthquakes, tsunamis, typhoons, landslides, floods, droughts, volcanoes, wildfires, storms, heat waves, and cold waves), the researchers identified and defined a framework based on references from other research papers. According to the references, the indicator for risk perception and risk response to natural hazards was developed in alignment with science curriculum text analysis.
	⇩	
Step 4	Categorization of the frame-work into risk perception and response indicators	Researchers categorized the framework into: 1) categories; 2) subcategories; 3) indicators for analysis in curriculum text; and 4) example items for curriculum analysis. As a result, the catego-rization of the framework for risk perception and risk response was developed and used as the foundational tool in this study, as shown in Table 5.
	⇩	
Step 5	Document analysis	An analysis was conducted on the explanations of texts regarding risk perception and response to natural hazards within the science curriculum documents, based on the categorization of risk perception and response analysis indicators developed in the previous stage.
	⇩	
Step 6	Data interpretation	After analyzing the documents, the results were compiled and presented in Table 6.

Selection of Countries

The World Risk Index 2023 evaluated the risk of disasters across 193 nations, including all UN countries, which account for almost 99 percent of the global population (Bündnis Entwicklung Hilft & Institute for International Law of Peace and Armed Conflict, 2023). According to the World Risk Report (WRR) 2023 data and the classification of the risk impact of natural hazards, the countries' sampling is shown in Table 1.

https://doi.org/10.33225/jbse/25.24.239

ISSN 1648-3898 /Print/
ISSN 2538-7138 /Online/

Table 1
The Selected Countries of Risk Perception and Response to Natural Hazards

Risk impact classification	Country
Very high	Indonesia
High	South Korea
Medium	United Kingdom
Very low	Singapore

According to the classification of risk impact from natural hazards in the World Risk Report Data 2023, Indonesia stands out as the nation with the highest risk impact. Closely following, South Korea is classified with a high-risk impact. The United Kingdom is positioned with a classification indicating a medium-risk impact, while Singapore, in contrast, exhibits a remarkably low-risk impact regarding natural hazards. As indicated in Table 1, this study selected countries based on risk impact classifications ranging from very high to very low. Therefore, Indonesia, South Korea, the United Kingdom, and Singapore were chosen for this research.

Selection of Natural Hazard Types

The criteria for selecting data in this study were based on the frequency of natural hazard occurrences, the number of deaths, the total number of affected humans, economic losses, and the biggest natural hazard in history to track the largest effect on the world. The selection of natural hazard types was based on the data below.

1. The data from the Centre for Research on the Epidemiology of Disasters (CRED)
2. The biggest natural hazard occurrence in history

The data on the impact of natural hazards, sorted by type in 2022, were compared to the 2002 - 2021 annual average in the world (CRED, 2022) and are shown in Table 2.

Table 2
The Data of Natural Hazards Impact in 2022 Compared to the 2002 - 2021 Annual Average in the World (CRED, 2022)

Type of natural hazards	NO*		ND*		TAH* (million)		EL* (billion US$)	
	2022	2002-2021	2022	2002-2021	2022	2002-2021	2022	2002-2021
Drought	22	16	2601	1057	106.9	70.5	2601	1057
Earthquake	31	27	1626	35124	3.6	5.5	1626	35124
Extreme temperature	12	19	16416	8538	0.1	4.8	16416	8538
Flood	176	168	7954	5195	57.1	80.1	7954	5195
Landslide	17	18	403	838	0.1	0.2	403	838
Mass movement	0	1	0	37	0	0	0	37
Storm	108	104	1611	10006	16.8	36.9	1611	10006
Volcanic activity	5	6	6	90	0.1	0.3	6	90
Wildfire	15	11	76	82	0.2	0.7	76	82
Total	386	370	30693	60967	184.9	199	30693	60967

*NO: Number of Occurrences; ND: Number of Deaths; TAH: Total Affected to Humans; EL: Economic Losses

https://doi.org/10.33225/jbse/25.24.239

ISSN 1648–3898 /Print/
ISSN 2538–7138 /Online/

Table 2 shows the data on natural hazard impact, including the number of occurrences, the number of deaths, the total affected to humans, and the economic losses in the world. According to the data presented in the Number of Occurrences (NO), it is evident that from 2002 – 2021 to 2022, various types of natural hazards, including droughts, earthquakes, extreme temperatures, floods, landslides, mass movements, storms, volcanic activities, and wildfires, increased in occurrence from 370 to 386 incidents. It indicates that the number of occurrences of natural hazards mentioned in Table 2 might continue to increase in the future. Owing to the prospective rise in the occurrence of disasters triggered by natural hazards, preparation is necessary to face such natural hazards. Moreover, the Number of Deaths (ND) in 2022 decreased compared to the period from 2002 – 2021; however, this number remains high. These data prove the continued loss of life resulting from the occurrence of natural hazards. Preparedness needs to be instilled and implemented to reduce the number of deaths caused by natural hazards. Additionally, the Total Affected to Humans (TAH), including physical injury, emotions, behavior, well-being, and thought, decreased slightly in 2022 compared to 2002-2021. The total number of affected humans differed by 14.1 million. Therefore, the optimization of risk management of natural hazards was required to further reduce human impact more effectively. Furthermore, the Economic Losses (EL) by these types of hazards significantly decreased from 2002 - 2021 to 2022. However, the figure of 30,693 billion US dollars still represents a considerable amount for the economic losses caused by natural hazards. Reducing the impact of these losses through risk management strategies is required. The natural hazards data in Table 2 indicates that the occurrence of these types of natural hazards will increase even further in the future and will have adverse impacts on humankind, including the number of deaths, affected individuals, and economic losses. Therefore, the types of natural hazards selected in this study included droughts, earthquakes, extreme temperatures, floods, landslides, storms, volcanic activities, and wildfires. In the case of extreme temperatures, this study considered both heat waves and cold waves. Mass movements were not considered because of their low impact and infrequent occurrence. Furthermore, according to Ayala-Carcedo (2001), the largest occurrence of natural hazards in history is illustrated in Table 3.

Table 3
The Biggest Natural Hazard Occurrence in History (Ayala-Carcedo, 2001)

Natural hazards	Area (Year)	Mortal casualties
Black death pandemics	Worldwide (1346-51)	175,000,000
Drought	India (1942)	1,500,000
Plague	Ireland (1845-47)	1,500,000
Flood	China (1887)	900,000
Earthquake	China (1556)	836,000
Typhoon	Bangladesh (1979)	500,000
Mud-flows	China (1920)	100,000
Tsunami	Krakatoa (1883)	36,417
Volcano	Mt. Pelée (1902)	29,000
Snow avalanches	Alpes (218 B.C)	19,000
Heatwaves	USA (1901)	9508
Tornado	USA (1925)	689

Based on the data obtained in Table 3, natural hazards such as typhoons and tsunamis were included in this study. The cases of the Black Death pandemic and plague were not considered in this research because these are not classified as natural hazards and were not influenced by geographic characteristics. Mudflows were considered part of landslides. Additionally, snow avalanches were not included because the selected countries for this study lacked sufficient snow conditions that could trigger snow avalanches, while tornadoes were considered as part of storms. According to these sources, this research assessed the combination of previously mentioned natural

https://doi.org/10.33225/jbse/25.24.239

ISSN 1648-3898 /Print/
ISSN 2538-7138 /Online/

hazards. Hence, the typical natural hazards analyzed in this study included earthquakes, tsunamis, typhoons, landslides, floods, droughts, volcanoes, wildfires, storms, and extreme temperatures (heat waves and cold waves).

Selection of Curricula

According to the science subject at the lower secondary level, the selected curricula of the countries are shown in Table 4.

Table 4
The Selected Curricula of Risk Perception and Response to Natural Hazards

Country	Curriculum	Subject	Grade
Indonesia	Merdeka Curriculum 2022	Science	Lower secondary
South Korea	South Korea Curriculum 2022		
United Kingdom	Cambridge Lower Secondary Science 0893 Curriculum Framework 2020		
Singapore	Singapore Express and Normal (Academic) Curriculum 2021		

As outlined in Table 4, this research focused on the science curriculum for lower secondary students, typically aged between eleven and sixteen years, for each country. The lower secondary science subject was selected because the science curriculum varies at the primary and upper-secondary levels across countries. In the Indonesian curriculum, primary school students studied a mix of subjects, where the subjects were blended between science and social studies. Furthermore, at the high school level in Indonesia, the United Kingdom, and Singapore, science was divided into physics, chemistry, and biology, which differed from South Korea. In South Korea's high school curriculum, the science subjects included physics, chemistry, life science (biology), and earth science. In contrast, other countries included the study of the Earth in the geography subject, which was part of social studies. Since science had become a consistent subject at the lower secondary level across the selected countries in this study, the science curriculum of the lower secondary level was chosen for this research. Considering the diversity of curricula implemented within each country, this study limited its focus to the latest science curriculum from each nation, namely the Merdeka Curriculum 2022, in which 'Merdeka' means 'Independence,' is the latest national curriculum of Indonesia; the South Korea Curriculum 2022 of South Korea; the Cambridge Lower Secondary Science 0893 Curriculum Framework 2020 of the United Kingdom; and the Singapore Express and Normal (Academic) Curriculum 2021 of Singapore.

Framework

The framework was inspired by research conducted by Cai et al. (2023), which analyzed the connection between public disaster mitigation behavior and risk perception in Wenchuan geological hazard emergency management. The framework for risk perception and public mitigation behavior in disaster emergency management was proposed by Cai et al. (2023). It included two emergency management phases: 1) pre-disaster preparation and 2) mid-disaster emergency response. Cai et al. (2023) defined that the four primary characteristics of risk perception are perceived probability, perceived severity, fear, and self-efficacy. Perceived probability designates a person's assessment of whether a risk event might have adverse outcomes; perceived severity refers to a person's judgment regarding risk event will have severe consequences; fear implies an individual feeling if they experience a potential threat; self-efficacy is essentially a perceived assessment of handling disaster risks, which represents a person's confidence in their capacity to implement mitigation strategies and falls under the general category of risk perception (Cai et al., 2023). Participating in evacuation drills, accumulating disaster supplies, attending training on disaster prevention and mitigation, and acquiring disaster insurance are examples of proactive steps in advance of pre-disaster preparedness (Cai et al., 2023).

The framework of risk perception and response to natural hazards was compiled from various sources and references, including SCI journal research, information from UN agencies, theses, research institutes, and discussions among researchers who participated in this study. The items that were used included risk perception and pre-disaster mitigation behavior. Meanwhile, the item categorized under 'mid-disaster emergency response' was

https://doi.org/10.33225/jbse/25.24.239

ISSN 1648–3898 /Print/
ISSN 2538–7138 /Online/

excluded from the framework, as most countries have established disaster management agencies that implement field training through disaster simulations in schools to enhance students' preparedness for natural hazards, which was not relevant to the analytical focus of this science curriculum text document. In most curricula, risk perception and pre-disaster mitigation behavior are introduced as foundational knowledge or initial perceptions. These concepts are emphasized as essential from an early age and are systematically integrated into the curriculum. In the risk perception subcategories, the item 'fear' was excluded due to the challenges in analyzing its indicators within the curriculum text document. Therefore, based on the references mentioned above, the framework for risk perception and risk response within science curriculum was developed as shown in Table 5.

Table 5

The Framework for Risk Perception and Risk Response for Analysis in Curriculum Text

Categories	Subcategories	Indicators for analysis in curriculum text	Example item for curriculum analysis
Risk Perception	Perceived Probability	References to likelihood or probability of natural hazards occurring in specific contexts or conveyed the processes of natural hazards occur.	"Does the curriculum include examples that highlight the probability of natural hazards, or the processes of natural hazards occur (e.g., earthquakes, floods)?"
	Perceived Severity	Emphasis on the potential impact or consequences of natural hazards on human life, the environment, and property.	"Does the text describe the severity of impacts from hazards such as tsunamis, wildfires, etc.?"
	Self-efficacy	Perceive understanding and knowledge of dealing with natural hazards, which reflect students' belief in their ability against natural hazards	"Does the curriculum provide an understanding and knowledge into students' beliefs about the actions they need to take against natural hazards?"
Risk Response:	Evacuation Drill Activities	Content related to preventive measures, such as preparedness activities, warning tools or safety drills.	"Does the curriculum encourage learning about emergency preparedness (e.g. warning system tools, evacuation drills)?"
	Storage of Disaster Response Materials	Recommendations or guidelines for storing disaster or hazard response materials like food, water, and first-aid kits.	"Does the curriculum provide activities related to creating or understanding emergency kits?"
	Disaster Mitigation Training and Publicity	Importance of spreading awareness and engaging in disaster or hazard mitigation training.	"Are there references to participating in community disaster or hazard mitigation training, discussion on reducing hazard, disaster damage, or education campaigns?"

As shown in Table 5, the framework of risk perception and response to natural hazards was used to analyze the science curriculum of each country. The element of risk perception was the inclusion of content covering the causes, risk impact, and concern about topics ranging from the perceived probability of an event to the consequences of natural hazards (Avvisati et al., 2019; Ronan et al., 2001). Risk perception indicators included attitudes concerning the likelihood, awareness, beliefs, describing natural hazards, the effect of natural hazards, explaining natural hazards, the impact of natural hazards, information flows about natural hazards, knowledge about natural hazards, severity, showing curiosity, and threat intrusiveness (Avvisati et al., 2019; Pazzi et al., 2020; Ronan et al., 2001; Yildiz, 2022). The risk response indicator showed an explanation of actions and methods to mitigate natural hazards to ensure safety including knowledge about natural disaster mitigation, response, preparedness, prevention, reconstruction, risk reduction, and risk management of natural hazards (Alfi et al., 2019; Rocha, 2021; UNESCO & UNICEF, 2012).

Science Curriculum Text Document Analysis

The science curriculum text document was analyzed beginning with the researchers, who were provided with the framework in Table 5, assessing risk perception and response indicators towards natural hazards. After the researchers familiarized themselves with the set of frameworks for risk perception and response to natural hazards, the data collection commenced, and each curriculum was analyzed utilizing the content analysis method. Each researcher marked every phrase, sentence, and explanation on the text document of this science curriculum by referring to the framework's item of risk perception and response to natural hazards in the science curriculum of each country. The discussion was extended with an invitation to the professional and research team in the field of

https://doi.org/10.33225/jbse/25.24.239

ISSN 1648–3898 /Print/
ISSN 2538–7138 /Online/

science education. In this study, three researchers examined the curricula of Indonesia, South Korea, Cambridge (as representatives of the United Kingdom), and Singapore. Subsequently, the findings of the analysis were cross-checked and reviewed again in the second phase, which involved collaborative review sessions. The observation notes were consulted during the conversation to enhance the validity of the results. The coding was considered to create valid data if the codes correspond to the criteria of correct decision-making standards (Potter & Donnerstein, 1999). According to the framework for each of the items studied, the researchers independently analyzed and evaluated the classification of identification. To minimize bias and enhance the consistency of the interpretations, the data results were reviewed and voted on based on agreement and disagreement among the researchers. The level of consistency of the result was determined by comparing their classifications with each other. After analyzing the science curriculum text document, the identification results are shown in Tables 6 and 7.

Research Results

The analysis of elements related to risk perception and response framework to natural hazards in the science curriculum of Indonesia, South Korea, the United Kingdom, and Singapore is shown in Table 6.

Table 6
Risk Perception and Response Distribution to Natural Hazards in the Science Curriculum

NHP*	Indonesia Merdeka curriculum 2022		South Korea curriculum 2022		Cambridge Lower Secondary Science 0893 Curriculum Framework 2020		Singapore Express and Normal (Academic) Curriculum 2021	
	RP*	RR*	RP*	RR*	RP*	RR*	RP*	RR*
Earthquake	O	O	O	O	O		O	
Tsunami	O	O					O	
Typhoon			O	O				
Landslide								
Flood					O			
Drought					O			
Volcanoes	O		O	O	O		O	
Wildfire								
Heat wave								
Storm								
Cold wave								

*NHP: Natural Hazard Phenomenon; RP: Risk Perception; RR: Risk Response; O: appears within the science curriculum

Table 6 illustrates the result of indicators related to risk perception and response to natural hazards in the science curriculum of Indonesia, South Korea, the United Kingdom, and Singapore. It shows that within the Indonesia Merdeka Curriculum 2022, both risk perception and response indicators are evident for earthquakes and tsunamis, while for volcanoes, only the risk perception indicator is present. Similarly, the South Korea Curriculum 2022 addresses both risk perception and risk response concerning earthquakes, volcanoes, and weather-related disasters, with typhoons commonly appearing in textbooks. In the case of the Cambridge Lower Secondary Science 0893 Curriculum Framework 2020, as representative of the United Kingdom, it addresses only risk perception related to earthquakes, volcanoes, floods, and droughts. Furthermore, the Singapore Express and Normal (Academic) Curriculum 2021 includes only the risk perception of earthquakes, tsunamis, and volcanoes. In addition, risk perception and response indicators for landslides, wildfires, heatwaves, storms, and cold waves are not fully integrated into any curriculum. The detailed findings of the exposition on risk perception and responses to natural hazards in the science curricula of Indonesia, South Korea, Cambridge (representing the United Kingdom), and Singapore are shown in Table 7.

https://doi.org/10.33225/jbse/25.24.239

ISSN 1648–3898 /Print/
ISSN 2538–7138 /Online/

Table 7
Risk Perception and Response in the Curriculum Text Document

Curriculum	Quoted text in the curriculum	Subcategory Identification	Categories
Indonesia Merdeka Curriculum 2022	"How do earthquakes and volcanic eruptions change human life?"	Self-efficacy	Risk perception
	"Why do not tsunamis always happen during earthquakes?"	Perceived probability	
	"Make an action campaign to anticipate before, during, and after earthquakes occur."	Disaster mitigation training and publicity	Risk response
	"Describe the effects of earthquakes and volcanoes on human life."	Perceived severity	Risk perception
	"Evaluating tsunami warning system tools and exploring other methods."	Evacuation drills activities	Risk response
South Korea Science Curriculum	"Choose and deal with the study case of a disaster such as the spread of infectious disease, chemical leaks, transportation accidents, earthquakes, volcanic eruptions and weather-related disasters, etc."	Perceived probability	Risk perception
	"Discuss ways to reduce damage, not only deal with post-mortem but also prevention and preparedness."	Disaster mitigation training, publicity, and Evacuation drills activities	Risk response
Cambridge Lower Secondary Science 0893 Curriculum Framework	"Describe how earthquakes, volcanoes, and fold mountains occur near the boundaries of tectonic plates."	Perceived probability	Risk perception
	"Describe the historical and predicted future impact of climate change, including sea level change, flooding, drought, and extreme weather events."	Perceived probability and severity	
Singapore Science Curriculum, the Singapore Express and Normal (Academic) Curriculum 2021	"Show curiosity about the destructive power of forces in nature (e.g., earthquakes, tsunamis, volcanic eruptions, tropical cyclones."	Perceived severity	

Table 7 presents the analysis and identification of risk perception and response in the curriculum text documents of Indonesia, South Korea, the United Kingdom, and Singapore. Through discussion and analysis among researchers, it was found that in Indonesia's Merdeka Curriculum 2022, as reflected in the Indonesia Science Textbooks of Lower Secondary by Lestari et al. (2021), three quotes were identified as representing risk perception, while two quotes were categorized under the risk response. In the South Korea Science Curriculum, as explained in the South Korea Curriculum 2022 - (22) Disaster and Safety (가) Achievement Standard Explanation [9과 22-01] and [9과 22-02], it shows that one quote was identified as risk perception, and another was categorized as risk response. Additionally, in the United Kingdom Science Curriculum, examples of passages of how the risk perception and response indicators were delivered in the Cambridge Lower Secondary Science 0893 Curriculum Framework, published by Cambridge Assessment International Education in 2020, showed that two quotes were identified under the risk perception category. Similarly, the Singapore Express and Normal (Academic) Curriculum 2021 [9: Application of Forces and Transfer of Energy] included a quotation focused on risk perception. According to the data analysis, it is evident that the risk perception category is prominently addressed within the science curriculum. Furthermore, the subcategories of 'perceived probability', 'perceived severity', and 'self-efficacy' are frequently emphasized within these science curricula.

The Distribution of Risk Perception and Response to Natural Hazards

The risk perception and response to natural hazards within the science curriculum of Indonesia, South Korea, the United Kingdom, and Singapore are supposed to be aligned with the natural hazards depending on their geographic characteristics. According to the research results, the findings of this research are shown in Table 8.

https://doi.org/10.33225/jbse/25.24.239

ISSN 1648-3898 /Print/
ISSN 2538-7138 /Online/

Table 8
The Distribution of Risk Perception and Response to Natural Hazards

<table>
<tr><th rowspan="3">Country</th><th rowspan="3">Geography characteristics</th><th rowspan="3">Type of natural hazard</th><th colspan="6">Within the science</th></tr>
<tr><th colspan="3">Risk Perception</th><th colspan="3">Risk Response</th></tr>
<tr><th>PP*</th><th>PS*</th><th>SE*</th><th>ED*</th><th>SD*</th><th>DM*</th></tr>
<tr><td rowspan="3">Indonesia</td><td rowspan="3">Ring of fire: tectonic belt, volcanic mountain, sea</td><td>Earthquake</td><td>O</td><td>O</td><td>O</td><td>X</td><td>X</td><td>O</td></tr>
<tr><td>Tsunami</td><td>X</td><td>X</td><td>X</td><td>O</td><td>X</td><td>X</td></tr>
<tr><td>Volcanoes</td><td>O</td><td>O</td><td>O</td><td>X</td><td>X</td><td>X</td></tr>
<tr><td rowspan="8">South Korea</td><td rowspan="8">Coastlines along the south, east, and west seas, mountains, rivers, plains, tectonic plate boundaries along the Pacific Rim, within the path of many typhoons (western part of the North Pacific Ocean), thick snow across South Korea because China gathered moisture from the warmer Yellow Sea</td><td>Typhoon</td><td>O</td><td>X</td><td>X</td><td>O</td><td>X</td><td>O</td></tr>
<tr><td>Storm</td><td colspan="6" rowspan="5">X</td></tr>
<tr><td>Wildfire</td></tr>
<tr><td>Flood</td></tr>
<tr><td>Landslide</td></tr>
<tr><td>Cold wave</td></tr>
<tr><td>Volcanoes</td><td>O</td><td>X</td><td>X</td><td>O</td><td>X</td><td>O</td></tr>
<tr><td>Earthquake</td><td>O</td><td>X</td><td>X</td><td>O</td><td>X</td><td>O</td></tr>
<tr><td rowspan="7">United Kingdom</td><td rowspan="7">Hills, low mountains, rivers, beaches, plentiful rainfall, sediment along the eastern and northern coast of Scotland, the northwest corner of Wales is, tectonic seismically active places (low-moderate seismic), during summer reach high temperatures in the southeast of England (closest to European mainland)</td><td>Flood</td><td>O</td><td>O</td><td>X</td><td colspan="3" rowspan="7">X</td></tr>
<tr><td>Drought</td><td>O</td><td>O</td><td>X</td></tr>
<tr><td>Landslide</td><td colspan="3" rowspan="3">X</td></tr>
<tr><td>Heat wave</td></tr>
<tr><td>Tsunami</td></tr>
<tr><td>Earthquake</td><td>O</td><td>X</td><td>X</td></tr>
<tr><td>Volcanoes</td><td>O</td><td>X</td><td>X</td></tr>
<tr><td rowspan="3">Singapore</td><td rowspan="3">Low-lying and flat terrain</td><td>Earthquake</td><td>X</td><td>O</td><td>X</td><td colspan="3" rowspan="3">X</td></tr>
<tr><td>Tsunami</td><td>X</td><td>O</td><td>X</td></tr>
<tr><td>Volcanoes**</td><td>X</td><td>O</td><td>X</td></tr>
</table>

**Note*: PP: perceived probability; PS: perceived severity; SE: self-efficacy; ED: evacuation drill activities; SD: storage of disaster response materials; DM: disaster mitigation training and publicity; **: Types of natural hazards that infrequently occur in their respective countries but are included in the curriculum; O: appears within the science curriculum; X: does not appear within the science curriculum

As depicted in Table 8, within the Indonesia Merdeka Curriculum 2022, the risk perception and response related to natural hazards that frequently occur in Indonesia, such as earthquakes and tsunamis, which are appropriate for the country's geographic context. However, the risk response for tsunamis does not align well with the geographic characteristics of the region. Similarly, the South Korea Curriculum 2022 appropriately addresses the risk perception and response to typhoons, which are relevant to South Korea's geographic context. However, the expressions of risk perception and response to storms, wildfires, floods, landslides, and cold waves in the science curriculum are not well-suited to the specific geography of South Korea. In addition, the curriculum includes both risk perception and risk response related to volcanoes and earthquakes, indicating that these aspects are aligned with geographic features associated with events that occur infrequently in the region. Regarding the United Kingdom and its Cambridge Lower Secondary Science 0893 Curriculum Framework 2020, the risk perception of floods and droughts aligns with the geographic characteristics of the United Kingdom. However, the risk response for floods or droughts is not mentioned. Additionally, the risk perception and response related to landslides, heatwaves, and tsunamis are not relevant to the context of the geographic characteristics of the United Kingdom. Furthermore, the curriculum addresses only the risk perception of earthquakes and volcanoes, which is appropriate for the local geography, however, it does not include a risk response to these hazards. In Singapore, the Singapore Express and Normal (Academic) Curriculum 2021 addresses only the risk perception of earthquakes and tsunamis, which are relevant to the country's geographic area. Additionally, the curriculum includes volcanoes, which are not common

https://doi.org/10.33225/jbse/25.24.239

ISSN 1648-3898 /Print/
ISSN 2538-7138 /Online/

natural hazards in Singapore. This suggests that the inclusion of volcanoes is more influenced by the geographical characteristics of surrounding countries.

Discussion

The results obtained in this study indicate that the distribution of risk perception and responses to natural hazards in specific science curricula is not appropriately aligned with the geographic characteristics of the respective regions. Moreover, the study reveals an imbalance in the coverage of risk perception and response to natural hazards within the lower secondary science curriculum. According to the findings, the risk perception category is prominently addressed within the science curriculum. To achieve a more balanced perspective, it is essential not only to emphasize the risk perception but also to explore more the risk response aspect of natural hazards. Balancing both risk perception and response will enable individuals or communities to manage the impacts of inevitable natural hazards. Through this study, the explanation of risk perception and risk response to natural hazards in the science curricula of Indonesia, South Korea, the United Kingdom, and Singapore were analyzed to reduce the risk of natural hazards and increase the risk management of natural hazards within school curricula, especially the science curriculum at lower secondary. Learning about risk perception and risk response to natural hazards within the science curriculum is crucial for mitigating and reducing the impact of such natural hazards, particularly for students. Modifying the distribution of risk perception and response concerning natural hazards within the science curriculum would be advantageous.

The improvement in the distribution of risk perception and response within the science curriculum will undoubtedly enhance knowledge and mitigate the risk of natural hazards. For instance, Japan had the biggest 9.0 magnitude earthquake and tsunami in 2011, and Turkey-Syria's 7.8 magnitude earthquake in 2023. According to the Asian Disaster Reduction Center (ADRC) and the International Recovery Platform (IRP) (2011), the earthquake and tsunami in Japan killed 14,508 people. In contrast, as reported by the U.S. Geological Survey (2023), the earthquake that occurred in Turkey-Syria killed 57,340 people. These data show that Japan has prepared for the worst-case effects of earthquakes and tsunamis. Japan has a good practice of assessing the response scenarios throughout every crisis, which is significant (Jimee et al., 2019). In Japan, disaster education is incorporated within the national curriculum, and the Ministry's curriculum guidelines of 2017 increased the amount of disaster education covered in foundational disciplines like science and social science (Sakurai et al., 2020). Thus, potentially furnishing its populace with risk perception and response strategies to mitigate and confront the impact of earthquakes and tsunamis, consequently, reducing the death of people resulting from these natural hazards. In terms of infrastructure, buildings in Japan are also constructed to be earthquake resistant. Japan's measures undertaken before the disaster or natural hazards strike, for instance, the construction of embankments and other hard-soft infrastructure measures (Jimee et al., 2019). This risk perception and response to earthquakes and tsunamis have greatly aided Japan in coping effectively with the impact. Conversely, alignment with research conducted by Demir (2023) has indicated that Turkey's theoretical preparation and structure for disaster and humanitarian relief were and continue to be highly flawed. Furthermore, research conducted by Kara & Özdemir (2020) has found that the majority of students knew only a few preventive practices related to response to natural hazards, and there were notable significant differences between schools and localities. These could be the reasons why Turkey-Syria has experienced a higher number of fatalities, extensive infrastructure damage, and a greater number of casualties compared to Japan. It proves the importance of learning about risk perception and response to natural hazards in education, particularly in science.

This study suggests broadening the understanding of risk perception and response to natural hazards beyond those present within the country itself through a global curriculum in the science subject. Following the findings outlined in the PISA 2018 Science Evaluation Framework and Evaluation Instruments (Korea Institute for Curriculum and Evaluation, 2019), it is evident that national question problems constitute 60.9% of the evaluation, whereas worldwide question problems comprise 29.6%. These statistics underscore the significance of addressing national question problems in educational curricula, while also emphasizing the importance of incorporating worldwide problem-solving skills into learning objectives. Therefore, developing a global curriculum addressing risk perception and response to natural hazards would enhance global preparedness. Such a curriculum could significantly contribute to assessing students' comprehension of natural hazards, potentially mitigating the impacts of such events.

Additionally, this research can contribute to helping individuals deal with the damage caused by natural hazards while residing in or visiting another country for a trip, work, or study abroad. In line with the research conducted by Rocha et al. (2021), the study has highlighted that the majority of international students believe

https://doi.org/10.33225/jbse/25.24.239

ISSN 1648–3898 /Print/
ISSN 2538–7138 /Online/

they are at risk, however, nearly all of them are unsure of how to respond. Focusing on natural hazards exclusive to the home country within the science curriculum may prove insufficient when individuals are situated in a different geographic location or characteristic. A curriculum that integrates insights into the diverse natural hazards characteristic of different regions prepares individuals to navigate unforeseen natural hazards. By recognizing the array of potential threats in various natural hazards, science education assumes a crucial role in cultivating a globally aware and resilient population.

The distribution of risk perception and response to natural hazards within science curricula is essential. However, the material on natural hazards should not be confined to science subjects alone, it can also be addressed with social curricula. For instance, the Korean social studies curriculum [9사(지리)08-03] emphasizes the importance of daily preparedness for natural hazards as shown below.

"*Identifying the geographical characteristics of natural hazards in Korea and efforts to minimize the damage and explore their responses in the event of natural hazards in various situations in daily life.*"

However, since it focuses solely on the risk response to natural hazard occurrences, it is challenging to present the process of risk perception to students through social subjects. Therefore, a scientific analysis of the phenomena that cause natural hazards, along with the exploration of risk perception through the science curriculum, is essential for preparing modern citizens. There is a need for collaboration between science and social studies to integrate risk perception and risk response into the science curriculum. According to Hodson (2021), when creating the science curriculum, it is valuable to distinguish among the four main types of learning objectives: (1) learning science, (2) learning about science and scientific practice, (3) doing science, and (4) addressing socioscientific issues (SSI). The SSI develops the critical ability to address the scientific, environmental, social, economic, personal, moral ethical elements of SSI and identify acceptable, socially responsible, and successful responses (Hodson, 2021). Organizing a collaborative activity can provide an understanding of risk perception and response related to natural hazards through a case study, such as a tsunami or a major earthquake that occurred in a certain area. Students would analyze the case and investigate how it happened from a scientific perspective. After understanding how natural hazards occur scientifically, students can comprehend information regarding natural hazard phenomena. Moreover, students can prepare themselves for mitigation steps by developing or creating a tool, such as an early warning system that applies scientific concepts. In addition, these science subject activities can be integrated with social subjects. For instance, students can explore more deeply the social impact of a major natural hazard case. Students are able to analyze how the affected community responded to the disaster, how the government and international organizations provided aid, and the socio-economic impact of the post-disaster situation. In this way, students can also learn how to minimize the large-scale social and community impact of natural hazards.

Conclusions and Implications

This study analyzed the distribution of risk perception and response towards natural hazards (earthquakes, tsunamis, typhoons, landslides, floods, droughts, volcanoes, wildfires, storms, heat waves, and cold waves) is addressed within the lower secondary science curricula of Indonesia, South Korea, the United Kingdom, and Singapore. This research aims to enhance the coverage of risk perception of natural hazards and strategies for responding and reducing its impact within the science curriculum.

The results obtained in this study indicate that the distribution of risk perception and responses to natural hazards in specific science curricula is not appropriately aligned with the geographic characteristics of the respective regions. Moreover, the study reveals an imbalance in the coverage of risk perception and response to natural hazards within the lower secondary science curriculum. According to the findings, the risk perception category is prominently addressed within the science curriculum.

This study underscores the importance of balancing risk perception and response within the science curriculum to ensure a comprehensive understanding of natural hazards. A well-structured curriculum that integrates both aspects will better equip students to deal with natural hazards. Furthermore, the incorporation of global perspectives on risk perception and response within science curricula is crucial in preparing students for the diverse natural hazards they may encounter beyond their home countries. Internationally, it impacts individuals who travel, live abroad, or vacation outside their home countries, where natural hazards may differ. These individuals can develop risk perceptions and response strategies for unexpected natural hazard events. For instance, if an individual comes from a country with few coastlines and infrequent earthquakes, but then moves to a country like Japan, where

https://doi.org/10.33225/jbse/25.24.239

ISSN 1648–3898 /Print/
ISSN 2538–7138 /Online/

earthquakes and tsunamis are common, they need to be provided with knowledge about the associated risks and proper evacuation procedures to respond to these natural hazards. Additionally, collaboration between science and social studies is also necessary to provide a holistic approach to disaster education. Interdisciplinary learning activities, such as case studies and problem-solving tasks, can enhance students' understanding of the scientific, social, and economic dimensions of natural hazards. This study recommends revising the science curriculum to ensure a balanced distribution of risk perception and response. By incorporating a more integrated and interdisciplinary approach to disaster education, schools can help students develop the knowledge and skills necessary to anticipate, prepare for, and respond to natural hazards effectively.

Acknowledgments

This work was supported by the Ministry of Education of the Republic of Korea and the National Research Foundation of Korea (NRF-2022S1A3A2A01088439).

Declaration of Interest

The authors declare no competing interest.

References

Alfi, M., Darsiharjo., & Maryani, E. (2019). Development of natural disaster mitigation teaching materials to improve understanding of disasters. *Journal of Physics: Conference Series, 387*, Article 012079. https://doi.org/10.1088/1742-6596/1387/1/012079
Asian Development Bank. (2013). *The rise of natural disasters in Asia and the Pacific*. Independent Evaluation.
Asian Disaster Reduction Center & International Recovery Platform (IRP). (2011). *Great East Japan earthquake: Preliminary observations*. United Nations Office for Disaster Risk Reduction (UNDRR). https://www.undrr.org/publication/great-east-japan-earthquake-preliminary-observations
Asian Disaster Reduction Center. (2023). *Natural disaster databook 2022 an analytical overview*. Asian Disaster Reduction Center (ADRC). https://www.adrc.asia/publications/databook/DB2022_e.php
Avvisati, G., Sessa, E. B., Colucci, O., Marfè, B., Marotta, E., Nave, R., Peluso, R., Ricci, T., & Tomasone, M. (2019). Perception of risk for natural hazards in Campania Region (Southern Italy). *International Journal of Disaster Risk Reduction, 40*, Article 101164. https://doi.org/10.1016/j.ijdrr.2019.101164
Ayala-Carcedo, F. G. (2001). Natural disasters mitigation in the world and sustainable development: A risk analysis approach. *Boletin Geológico y Minero, 112*(4), 43–64. https://app.ingemmet.gob.pe
Bai, Z., Wang, Y., Li, M., Sun, Y., Zhang, X., Wu, Y., Li, Y., & Li, D. (2023). Land subsidence in the Singapore coastal area with long time series of TerraSAR-X SAR data. *Remote Sens, 15*, Article 2415. https://doi.org/10.3390/rs15092415
Berelson, B. (1952). *Content analysis in communication research*. Free Press.
Bertoli, A., Ng'asike, J. T., Amici, S., Madjar, A., & Tesar, M. (2023). Decolonizing western science education and knowledge in early childhood: Rethinking natural hazards and disasters framework through indigenous 'ecology of knowledges' in Kenya. *Global Studies of Childhood, 14*(2). 197–213. https://doi.org/10.1177/204361062311997
Bündnis Entwicklung Hilft & Institute for International Law of Peace and Armed Conflict. (2023). *World risk report 2023*. Bündnis Entwicklung Hilft.
Cai, J., Hu, S., Sun, F., Tang, L., Fan, G., & Xing, H. (2023). Exploring the relationship between risk perception and public disaster mitigation behavior in geological hazard emergency management: A research study in Wenchuan county. *Disaster Prevention and Resilience, 2*(201). http://dx.doi.org/10.20517/dpr.2023.26
Cambridge Assessment International Education. (2020). *Curriculum Framework Cambridge Lower Secondary Science 0893 Version 1*. https://cambridge-community.org.uk/guide-to/cambridge-lower-secondary/science/
Centre for Research on the Epidemiology of Disasters (CRED). (2015). *The human cost of natural disasters a global perspective*. The United Nations Office for Disaster Risk Reduction. https://www.preventionweb.net/publication/human-cost-natural-disasters-global-perspective
Centre for Research on the Epidemiology of Disasters (CRED). (2022). *2022 Disasters in numbers*. The United Nations Office for Disaster Risk Reduction https://www.preventionweb.net/quick/76957
Cerulli, D., Scott, M., Aunap, M., Kull, A., Pärn, J., Holbrook, J., & Mander, Ü. (2020). The role of education in increasing awareness and reducing impact of natural hazards. *Sustainability, 12*(18), Article 7623. https://doi.org/10.3390/su12187623
Darker, C. (2013). Encyclopedia of behavioral medicine. In M. D. Gellman & J. R. Turner (Eds.), *Risk perception*. Springer. https://doi.org/10.1007/978-1-4419-1005-9_866
Erlingsson, C., & Brysiewicz, P. (2017). A hands-on guide to doing content analysis. *African Journal of Emergency Medicine, 7*(3), 93-99. https://doi.org/10.1016/j.afjem.2017.08.001
Giles, D. P. (2020). Chapter 1 introducing to geological hazards in the UK: Their occurrence, monitoring and mitigation. *Geological Society, London, Engineering Geology Special Publications, 29*, 1–41. https://doi.org/10.1144/EGSP29.1
Hodson, D. (2021). Going beyond STS education: Building a curriculum for sociopolitical activism. *Canadian Journal of Science, Mathematics and Technology Education, 20*, 592–622. https://doi.org/10.1007/s42330-020-00114-6

ISSN 1648–3898 /Print/
ISSN 2538–7138 /Online/

International Federation of Red Cross and Red Crescent Societies. (2022). *World disasters report 2022*. International Federation of Red Cross and Red Crescent Societies. https://www.ifrc.org/document/world-disasters-report-2022

Javid, A. A., Fateminia, S. H., & Gemünden, H. G. (2020). A method for risk response planning in project portfolio management. *Project Management Journal*, *51*(1), 77–95. https://doi.org/doi.org/10.1177/8756972819866577.

Jimee, G. K., Meguro, K., & Dixit, A. M. (2019). Learning from Japan for possible improvement in existing disaster risk management system of Nepal. *Open Journal of Earthquake Research, 8*(2). https://doi.org/10.4236/ojer.2019.82006

Kang, S. H., & Skidmore, M. (2018). The effects of natural disasters on social trust: Evidence from South Korea. *Sustainability, 10*(9). https://doi.org/10.3390/su10092973

Kara, I., & Özdemir, N. (2020). Hazard perception and disaster information of Turkish secondary school students. *Journal of Education in Black Sea Region, 6*(1). https://doi.org/10.31578/jebs.v6i1.220

Keller, E. A., & DeVecchio, D. E. (2015). *Natural hazards: Earth's processes as hazards, disasters, and catastrophes* (4th ed.). Pearson Education.

Kim, D., & Yoon, H. (2020). Demographic effects of climate-induced disasters in South Korea: Spatiotemporal approach. *International Journal of Disaster Risk Reduction, 50*. https://doi.org/10.1016/j.ijdrr.2020.101837

King, J. M, & Blickensderfer, E. L. (2023). Chapter 20 – Human factors in general aviation weather. *Human Factors in Aviation and Aerospace (Third Edition)*, 543–562. https://doi.org/10.1016/B978-0-12-420139-2.00017-4

Korea Institute for Curriculum and Evaluation. (2019). *OECD programme for international students assessment: An analysis of PISA 2018 results* (RRE 2019-11). https://www.kice.re.kr/resrchBoard/view.do?seq=43767&s=kice&m=030103

Korean Ministry of Education. (2022). *Science curriculum* (proclamation of the Ministry of Education #2022-33 [Annex 9]). https://ncic.re.kr/english/dwn/ogf/inventoryList.cs

Koterba, K. (2019). *International study guide series united kingdom*. Montana State University and Montana 4-H Center for Youth Development.

Kwon, S., Kim, J., Lee, E., & Jung, C. (2016). *Geography of Korea* (D. Kane, Trans.). The Academy of Korean Studies.

Lai, A. Y. H., & Tan, S. L. (2014). Impact of disasters and disaster risk management in Singapore: A case study of Singapore's experience in fighting the SARS epidemic. *Resilience and Recovery in Asian Disasters: Community Ties, Market Mechanisms, and Governance, 18*, 309–336. https://doi.org/10.1007/978-4-431-55022-8_15

Lestari, S. H., Inabuy, V., Sutia., Maryana, O. F., & Hardanie, B. D. (2021). *Buku panduan guru ilmu pengetahuan alam* [Teacher's guidebook for natural sciences]. Pusat Perbukuan.

Mărgărint, M. C., Kovačić, S., Albulescu, A., & Miljković, Đ. (2023). Natural multi-hazard risk perception and educational insights among Geography and Tourism students and graduates amid the COVID-19 pandemic. *International Journal of Disaster Risk Reduction, 86*. https://doi.org/10.1016/j.ijdrr.2023.103549

Miles, M. B., Huberman, M. B., & Saldana, J. (2014). *Qualitative data analysis: A methods sourcebook* (3rd ed.). SAGE Publications.

Ministry of Education Singapore. (2020). *Science syllabuses lower secondary express course normal (academic) course implementation starting with 2021 secondary one cohort*. https://www.moe.gov.sg/secondary/courses/express/electives

National Geographic Information Institute. (2017). *The national atlas of Korea for children*. Ministry of Land, Infrastructure and Transport.

Pan American Health Organization. (1994). *A world safe from natural disasters: The journey of Latin America and the Caribbean*. Pan American Health Organization.

Pazzi, V., Morelli, S., & Bonati, S. (2020). *Disaster risk perception knowledge base – a consolidated understanding of disaster risk perception in social media and crowdsourcing research report*. European Uninon's Horizon. http://links-project.eu/deliverables/

Potter, W. J., & Levine-Donnerstein, D. (1999). Rethinking validity and reliability in content analysis. *Journal of Applied Communication Research, 27*(3), 258–284. https://doi.org/10.1080/00909889909365539

Protschky, S. (2022). Disaster in Indonesia: Along the fault line toward new approaches. *Indonesia*, *113*, 1–8. https://doi.org/10.1353/ind.2022.0000

Rocha, E. L. S. (2021). *Risk perception and response among international students of the University of Southern Mississippi* [Master's thesis, University of Southern Mississippi]. USM Campus Repository. https://aquila.usm.edu/masters_theses/857

Ronan, K. R., Johnston, D. M., Daly, M., & Fairley, R. (2001). School children's risk perceptions and preparedness: A hazard education survey. *The Australasian Journal of Disaster and Trauma Studies, 2001*(1). https://www.massey.ac.nz/~trauma/issues/2001-1/ronan.htm

Sakurai, A., Sato, T., & Murayama, Y. (2020). Impact evaluation of a school-based disaster education program in a city affected by the 2011 great East Japan earthquake and tsunami disaster. *International Journal of Disaster Risk Reduction, 47*. https://doi.org/10.1016/j.ijdrr.2020.101632

Sjöberg, L., Moen, B. E., & Rundmo, T. (2004). *Explaining risk perception: An evaluation of the psychometric paradigm in risk perception research*. Rotunde.

Slovic, P. (1987). Perception of risk. *Science, 236*(4799), 280–285. https://doi.org/10.1126/science.3563507

Stock, M., & Wentworth, J. (2019). *Evaluating UK natural hazards: the national risk assessment*. UK Parliament Post. https://doi.org/10.58248/PB31

Sweeting, P. (2017). *Financial enterprise risk management*. Cambridge University Press. https://doi.org/10.1017/9781316882214.017

Thomas, D. R. (2006). A general inductive approach for analyzing qualitative evaluation data. *American Journal of Evaluation*, *27*(2), 237–246. https://doi.org/10.1177/1098214005283748

Tyas, R. A., P, Suyanta. (2020). Integrating disaster risk reduction with science education to student of junior high school in Merapi Mountain areas, Indonesia. *International Journal of Engineering Research and Technology, 13*(12), 4551–4557. http://www.irphouse.com/

https://doi.org/10.33225/jbse/25.24.239

U.S. Geological Survey. (2023). *Frequently asked questions about 2023 earthquakes in Türkiye*. Earthquake Hazards Program. https://www.usgs.gov/programs/earthquake-hazards/science/frequently-asked-questions-about-2023-earthquakes-turkiye

UNESCO & UNICEF. (2012). *Disaster risk reduction in school curricula: Case studies from thirty countries*. UNICEF. https://unesdoc.unesco.org/ark:/48223/pf0000217036

UNICEF. (2020). *Disasters and natural hazards: How to prepare, respond and recover*. UNICEF. https://www.unicef.org/easterncaribbean/reports/disasters-and-natural-hazards

International Strategy for Disaster Reduction. (2009). *Reducing disaster risks through science: Issues and actions*. United Nations Office for Disaster Risk Reduction. https://www.undrr.org/quick/11087

Yildiz, A. (2022). *Analysing children's natural hazard risk perception and preparedness using a modified PRISM Approach* [Master's thesis, University of Portsmouth]. UoP Campus Repository. https://researchportal.port.ac.uk/en/studentTheses/analysing-childrens-natural-hazard-risk-perception-and-preparedne

Received: *February 18, 2025* Revised: *February 24, 2025* Accepted: *March 28, 2025*

Cite as: Dewi, N. W. R. U., Jang, W., & Kim, M. (2025). Risk perception and response to natural hazards within science curriculum. *Journal of Baltic Science Education*, *24*(2), 239–254. https://doi.org/10.33225/jbse/25.24.239

Ni Wayan Rai Utari Dewi — Master Student, Department of Physics Education, Kongju National University, Republic of Korea.
E-mail: raiutaridewi@gmail.com
ORCID: https://orcid.org/0009-0004-0699-826X

Wonbin Jang — PhD Student, Department of Physics Education, Kongju National University, Republic of Korea.
E-mail: jwb200065@smail.kongju.ac.kr
ORCID: https://orcid.org/0009-0005-6694-6389

Minchul Kim *(Corresponding author)* — PhD, Associate Professor, Department of Physics Education, Kongju National University, Republic of Korea.
E-mail: mckim@kongju.ac.kr
ORCID: https://orcid.org/0000-0003-2911-7758